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ABSTRACT

To examine the feasibility and effects of implementing relaxation training with a heterogeneous group of secondary school students in the classroom setting, and to determine the validity and reliability of using wrist temperature as a biofeedback method, 532 seventh grade students, divided into experimental and control groups, participated in a stress management program as part of the regular school curriculum. The experimental subjects (n=266) recorded their wrist temperatures immediately before and after a 15-minute relaxation training exercise at the beginning of each school day for 9 months. Data were also collected on discipline referrals for the control and experimental groups, and all subjects completed the Comprehensive Tests of Basic Skills and the Self-Observation Scales at the end of the study. An analysis of the results showed that relaxation training can be successfully implemented in the classroom with limited teacher training and classroom disruption. Wrist temperature proved to be both a valid and reliable measure of the relaxation state. All students showed improvement, though they varied greatly in their ability to elicit the relaxation response. The ability to relax was not found to be significantly related to sex or race, but appeared to be related to cognitive abilities. Subjects receiving the training had fewer discipline problems and significantly higher self-concepts. The findings suggest that relaxation training is beneficial to adolescents and can be easily implemented in the regular school curriculum. (BL)

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THE EFFECTS OF RELAXATION TRAINING USING WRIST TEMPERATURE AS BIOFEEDBACK IN AN EDUCATIONAL SETTING

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THE EFFECTS OF RELAXATION TRAINING USING WRIST TEMPERATURE AS BIOFEEDBACK IN AN EDUCATIONAL SETTING

Introduction

Young people today are faced with a greater variety of perceived pressures and anxiety-producing problems than previous generations. Peer pressures, school pressure, changes in the traditional nuclear family, even the changing economic structure and the overwhelming technology of our society combine to induce stress situations in young people. Running away from home, fighting, assaulting teachers, vandalism, and extreme anxiety about tests and other school work are common symptomatic behaviors and may establish lifelong patterns of negative response to stressful situations. In order to avoid these behaviors, children must learn to manage stress in a positive and constructive manner.

Certain techniques, such as the quieting reflex (QR), autogenics, and visual imagery, are shown to be effective in training people to relax (Holland, 1980; Lupin, 1977; Luthe, 1969; Stroebel, 1982). Findings dealing with hyperactive children tend to show that relaxation training improves affective behavior such as self-concept, distractability, irritability, explosiveness, aggressivity, and emotionality as well as cognitive behavior such as reading comprehension, vocabulary, language, arithmetic concepts, and reference skills (Braud, 1978; Braud, Lupin, & Braud, 1975; Carter, & Russell, 1978, 1981; Deffenbacher, & Snyder, 1976; Dunn, & Howell, 1982; Harlem, 1975;

Hussian, & Lawrence, 1978; Lupin, Braud, Braud, & Duer, 1976; Martin, & Hershey, 1976; Matthews, 1982; Miller, 1970; Omizo, 1980; Parsky, 1975; Patmon, & Murphy, 1978; Rivera, & Omizo, 1980; Walton, 1977; Watson, & Hall, 1977). Since little research is available on relaxation training with students not classified as hyperactive or learning disabled, this study examines a heterogeneous population. This approach develops techniques for implementing relaxation training in the regular classroom setting.

This study examines thermal biofeedback, specifically the temperature of the skin at the wrist. Skin temperature depends on the flow of blood through the arteries and arterioles. The sympathetic nervous system controls this circulation. Thus, changes in sympathetic nerve activity can be followed by changes in skin temperature. When relaxed, the blood flows out from the heart and lungs to provide nutrient-rich circulation to the periphery, increasing the skin temperature. When under stress, the blood flows toward the heart and lungs, lowering circulation in the skin and lowering skin temperature.

This research addresses the following questions:

1 Can relaxation training be implemented in the regular classroom?

2. Are wrist temperatures a valid and reliable method of biofeedback?

3. Is relaxation training effective on heterogeneous populations?

4. What are the positive effects of a relaxation training program?

The Sample

The population was seventh grade students in 10 public and private middle schools in a four county area in the midlands of South Carolina. The schools ranged from urban to rural with the socioeconomic levels of the parents from low to middle class.

The sample consisted of 532 students (260 girls and 272 boys) of which 273 were black and 259 white. Researchers selected students by sampling two intact classes of seventh graders from each school prior to the beginning of school. The principals arranged that the two classes within each school would have similar class schedules. At the time of selection, after schedules were constructed but prior to the opening of school, researchers combined the classes and formed two new classes randomly from the combination. Class sizes depended upon the original two classes and ranged from 20 to 35 students.

One of the two classes was the experimental, or treatment group; the other was the untreated control group. No students or teachers were aware of the pairing of classes since the information was known only to the principal and counselor in the school. The principal randomly assigned teachers to the two groups. The experimental group knew only that they would participate in a stress management program as part of the regular curriculum. Parents signed consent forms for their children to participate in the program.

The sampling plan achieved a large sample, blind to the existence and purpose of the study, assigned to directly comparable pairs of classes.

Procedure

The students in the experimental group participated in relaxation training exercises for approximately 15 minutes at the beginning of each school day during a nine month school year. The teachers played a series of audio-taped relaxation exercises, developed especially for middle school students, including such techniques as the quieting reflex, autogenics, and visual imagery.

Children recorded their wrist temperatures immediately before and after the relaxation exercises by using a wrist temperature indicator, a biofeedback instrument developed by Bio-Temp, Incorporated. The wrist indicator, worn like a wrist watch, utilized liquid crystal technology and was very sensitive to skin temperature changes. Wrist temperature increases as individuals become more relaxed. Therefore, pre- and postreadings of skin temperature provided a daily measure of the relaxation state and cumulative averages over time to determine the value of practice.

Throughout the school year, researchers also collected data on discipline referrals. At the end of the study, the children completed the Comprehensive Tests of Basic Skills (CTBS) and the Self Observation Scales (SOS), nationally normed instruments for measuring achievement (CTBS) and self-concept (SOS).

Ambient Stress

Ambient stress is the general stress level in a particular

setting. School may be a stressful situation for children, but some schools may be highly stressful, while others are extremely relaxed. Some stress is necessary, understimulation requiring increased stress and overstimulation requiring decreased stress to achieve the maximum degree of effective performance (Gmelch, 1977). Prereading (prior to the relaxation exercise) wrist temperatures provided a measure of ambient stress for each student. Averages across all the participating students in each school provided a measure of ambient stress in the schools.

Figure 1 depicts the means of the prereading wrist temperatures for each school. The number of observations in each case is the number of students in the class multiplied by the number of days of the project. The data are presented as part of Table 1 (with the exception that the first two classes given in the table were collapsed to one group in the graph since the two classes are in one school).

The means range from 83.89 °F (28.83 °C) to 90.36 °F (32.42 °C). The means, based on 1400 to 3600 cases each, are quite stable and indicate a reasonable measure of the stress level in each school. Obviously, schools are very different in how much stress they produce. It is still not known what level of stress is optimal, only that neither extremely low nor extremely high levels of stress are beneficial.

These initial (prereading) wrist temperatures are related to how much increase can be expected during the relaxation exercise. The correlation between prereading wrist temperatures and the increase in wrist temperatures from prereading to postreading is -.39. Logically, the more relaxed an individual is initially

Figure 1

Ambient Stress Levels

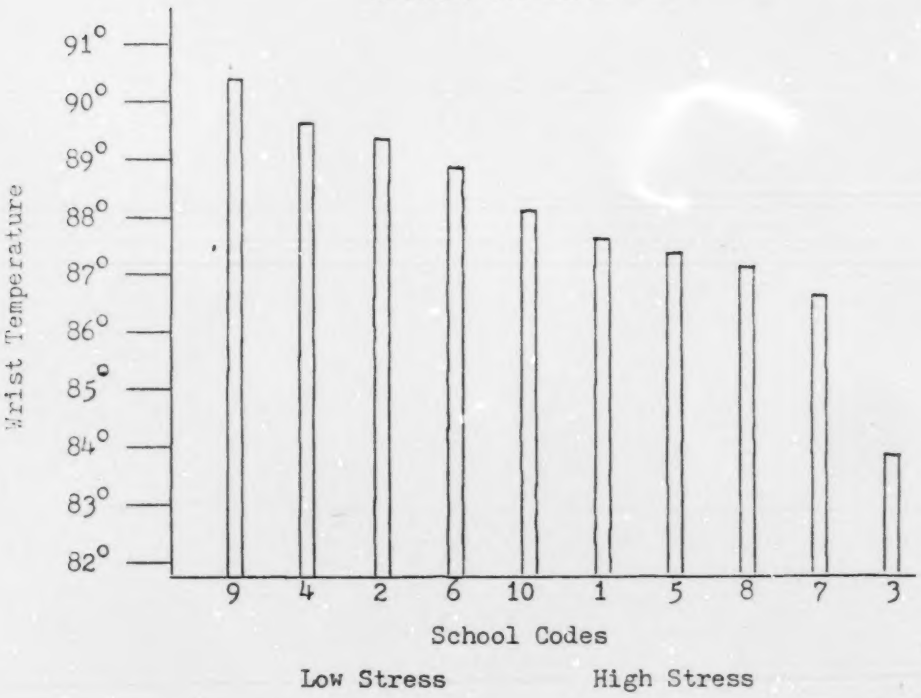


Table 1

Wrist Temperature Means

Class	N	Pre Mean	Post Mean	Mean Difference
1	1280	89.17	92.34	3.17
2	1557	86.71	89.73	3.02
3	2901	89.20	91.29	2.09
4	1409	83.89	86.30	2.44
5	2965	89.50	92.56	3.06
6	2556	87.75	89.59	1.84
7	1550	88.88	91.91	3.03
8	2482	86.74	88.84	2.12
9	2215	87.20	90.11	2.90
10	3674	90.36	92.66	2.31
11	2728	88.04	90.77	2.73

Note: All figures and tables reporting temperatures use degrees Fahrenheit.

(high wrist temperature), the less change (increase) may be expected. Conversely, individuals who are tense can relax more (from low wrist temperatures to high).

Pre-Post Change in Wrist Temperatures

Differences were anticipated among the eleven classes in their ability to relax, and thus in their mean wrist temperature increases. There may be a variety of reasons for interclass differences, such as classroom environment, teacher enthusiasm, peer influence, and length of available time. The mean prereading, postreading, and difference (post minus pre) wrist temperatures for each of the eleven classes are presented in Table 1. There are clear differences across class, with the mean increase ranging from 1.84 °F (1.02 °C) to 3.17 °F (1.76 °C).

With the classroom used as the unit of analysis (n=11), a dependent t test was conducted between the prereading and postreading to determine whether the increase in wrist temperatures was significant. The t value of 18.64 was significant at the pre-established .05 level of significance. Actually the exact probability of the t value is less than .0001. This finding indicates that the relaxation exercises were effective in raising wrist temperatures, the measure of relaxation response in the study.

The Effect of Practice on Changing Wrist Temperatures

The effects of time and practice on relaxation skills were examined by studying the changes in wrist temperatures as the

project progressed. The wrist temperature readings were compiled by taking the mean across all the experimental students and across the five days of each week in the twenty-nine weeks of the project. These means are reported in Table 2 for the prereading, the postreading, and the difference (increase from the prereading to the postreading). The table shows an increase (positive difference) for each of the twenty-nine weeks from September 20 to April 29.

The weekly mean wrist temperature differences are graphically displayed as a time-series in Figure 2 (solid line). If practice is an important factor in learning to relax, the change in wrist temperatures should increase as the project proceeds. A Pearson product moment coefficient of correlation was computed between the week and the mean increase in wrist temperatures. A correlation of .76 was found, which is significant at the .05 level. This shows that practice may be an important factor in learning relaxation skills. The decreases which are most apparent are at weeks 7 (Halloween), 13 (Christmas), and 23 (Spring Break) indicating the heightened tension which surrounds such holidays and perhaps the regression caused by having a break in the daily relaxation routine.

Ambient Temperature

The postreading temperature attained is largely a function of the prereading temperature. The correlation between the prereading and postreading wrist temperatures is a significant 0.96 (n=29). With postreading temperatures so apparently dependent on prereading temperatures, it seems more valuable to

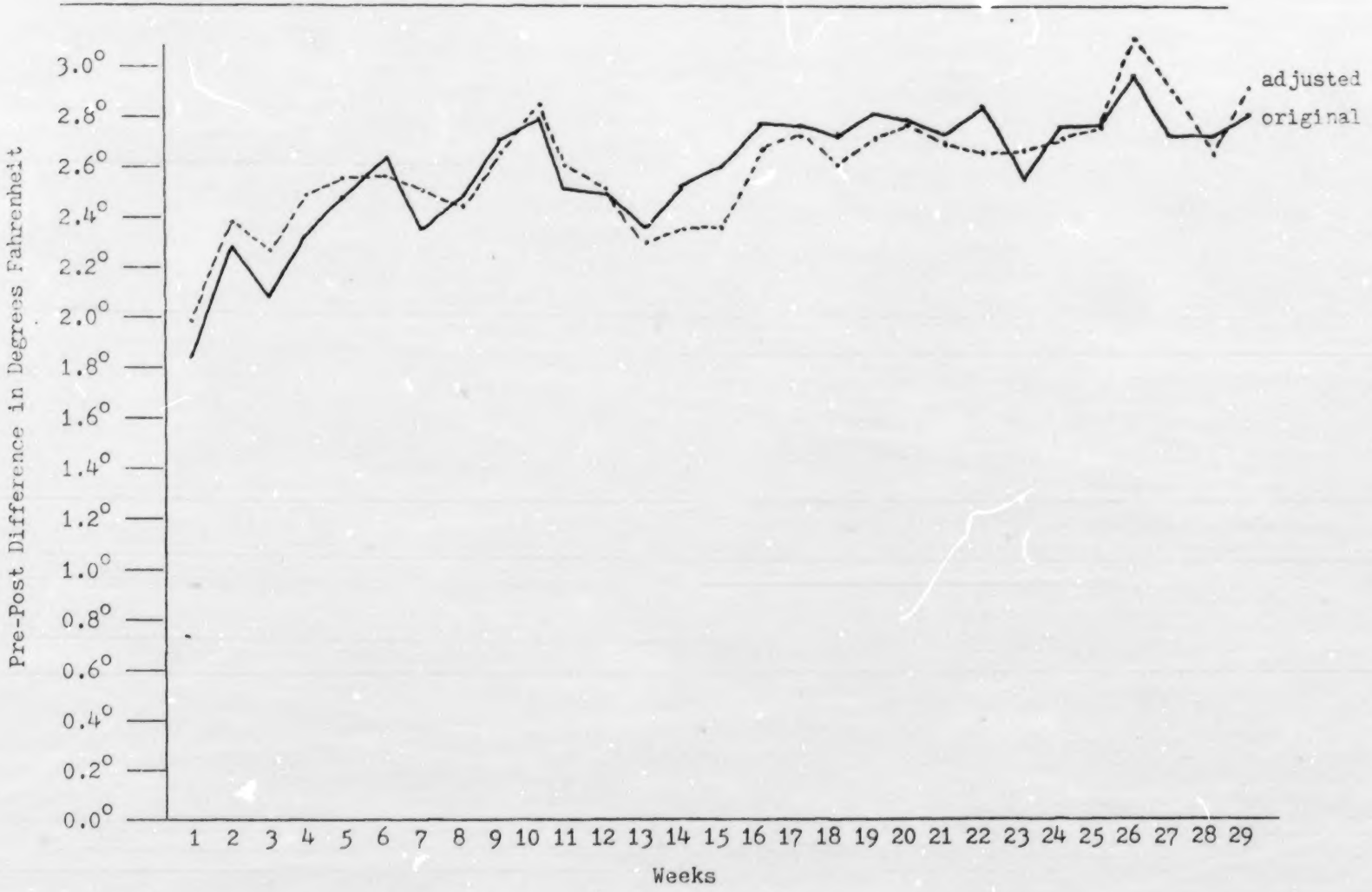
Table 2

Weekly Wrist and Ambient Temperatures

Week	Prereading Temperature	Postreading Temperature	Difference	Ambient Temperature	Corrected Difference
1	89.36	91.18	1.82	55.6	1.98
2	88.56	90.81	2.27	53.0	2.38
3	89.88	91.96	2.07	56.6	2.25
4	89.23	91.56	2.33	55.8	2.49
5	88.69	91.16	2.48	48.4	2.55
6	87.93	90.54	2.62	36.2	2.56
7	89.44	91.81	2.37	50.2	2.47
8	88.09	90.53	2.44	36.6	2.40
9	87.59	90.28	2.69	37.4	2.65
10	89.08	91.87	2.79	43.2	2.83
11	89.77	92.24	2.47	50.8	2.58
12	88.09	90.52	2.45	43.8	2.46
13	87.81	90.17	2.38	30.6	2.25
14	87.45	89.93	2.47	29.6	2.36
15	86.19	88.78	2.59	20.4	2.37
16	87.76	90.51	2.75	29.8	2.63
17	88.21	90.93	2.72	36.6	2.69
18	87.44	90.13	2.69	27.0	2.54
19	87.69	90.47	2.78	29.6	2.66
20	88.08	90.83	2.75	40.2	2.74
21	88.04	90.75	2.71	37.6	2.68
22	88.48	91.32	2.84	47.8	2.60
23	88.17	90.75	2.58	44.2	2.61
24	87.44	90.17	2.74	36.4	2.68
25	86.99	89.74	2.74	39.8	2.71
26	90.05	93.01	2.96	51.4	3.08
27	87.82	90.54	2.71	49.2	2.81
28	87.22	89.92	2.71	33.2	2.61
29	87.61	90.38	2.77	44.6	2.82

Figure 2

Time-Series Graph of Weekly Average Increase in Wrist Temperature and Corrected Average Increase in Wrist Temperature



examine only the increase or difference scores (post minus pre). However, researchers must account for the wide variation in prereading temperatures. If the prereading temperatures indicate the degree of relaxation the student has upon entering, then this valuable information would be lost in the use of difference scores. If, on the other hand, prereading temperatures are merely a function of ambient temperature, then only the increase in temperature would provide useful data.

Ambient temperature was defined as the average low temperature over each five-day school week as measured by the South Carolina Central #2 (Orangeburg) Weather Station. Table 2 gives the mean ambient temperature for each of the twenty-nine weeks of the project along with the prereading, postreading, and difference wrist temperatures. The correlation between ambient temperature and prereading wrist temperature is .82. Thus, the outside temperature accounts for 67% of the variation in initial wrist temperatures ($r^2 = .67$) which in turn account for 93% of the variation in postreading wrist temperatures ($r^2 = .93$).

A Method for Adjusting Wrist Temperatures

Actual wrist temperatures clearly are largely a function of ambient temperature. Researchers adjusted wrist temperatures using a simple regression technique. Prereading and postreading wrist temperatures were regressed on ambient temperatures individually and the residuals from the regression line became the new data points. To return the data to the original scale, the residuals were added to the mean of the original data points. When this procedure was done with both prereading and postreading

data, the difference between the new measures became the new adjusted wrist temperature increases.

Table 2 presents the adjusted mean temperature increases for each of the twenty-nine weeks of the project. The data is presented graphically in Figure 2 (dotted line) where it may be directly compared with the increases prior to the adjustment. The adjusted increases are correlated with the week at .68 (n=29) just slightly lower than the correlation with the original differences.

Adjusting temperatures for ambient temperature appears to change the pre-post increase only slightly. The adjustments to the actual prereadings and postreadings are much more dramatic due to their higher correlations with ambient temperature. As a result of this part of the study, the authors have three suggestions concerning ambient temperature. (1) If one measures pre-post difference in a setting where ambient temperature does not change, adjusting wrist temperature is probably unnecessary. (2) If the ambient temperature changes between the prereading and the postreading, the wrist temperatures should be adjusted. (3) If one examines single temperature measures (rather than pre-post) in a longitudinal study of general stress level, the temperatures should be adjusted for ambient temperature.

Results

Results of the Study of Discipline Infractions

Table 3 reports the frequencies of discipline infractions

Table 3

Frequency Table and Z-Test of Discipline Infractions
Between the Control and Experimental Groups

	Control n=265	Experimental n=266	Z-value	
Total of discipline infractions reported to school office	264	188	3.574	*

* indicates a significant z-value at the .05 level of significance, with an exact probability less than .0003

for the control and experimental groups and the results of a z test of significance between the two proportions. The z value of 3.574 is significant at the .05 level of significance, indicating that the number of discipline problems differ between the control group and the experimental group. The data are further separated into seventeen specific discipline violations in order to determine exactly which types of unacceptable behavior have been affected by the relaxation training. Three of these infractions had no incidents in either the experimental or control groups. The data for the remaining fourteen viclations are reported in Table 4. Z tests were conducted for nine of these fourteen areas and are reported in Table 4. Of the nine behavior types tested, only the discipline problems of "fighting" and "cutting class" have significant z values at the .006 level of significance. An alpha level of .006 is used in this case to produce an approximate family-wise error rate of .05 for the nine tests. The control group had a higher number of instances of fighting than did the experimental group. This result supports the hypothesis that students with relaxation training will exhibit fewer instances of explosive types of behavior compared to students without training, since the "fighting" category is the most explosive of the discipline categories.

The results of the z tests support the hypothesis that there are significantly fewer discipline problems among students who receive the relaxation training than among those who do not receive the training. Apparently, the relaxation program decreases the number of incidents of disruptive behavior, particularly cutting class and such explosive behavior as

Table 4

Frequency Table and Z-Tests of Discipline Infractions
by Category Between the Control and Experimental Groups

Infraction	Control n=265	Experimental n=266	Z-value
cutting class	14	3	2.678 **
leaving campus without permission	1	2	*
loitering in unauthorized areas	3	5	*
persistent disobedience	66	56	1.000
excessive noise/attention getting	35	31	0.493
persistently disturbing another student	26	19	1.044
disrespect/insubordination	43	32	0.058
threatening/intimidating staff	6	3	*
theft/cheating/gambling	0	1	*
fighting	30	10	3.165 **
vandalism	1	0	*
physical abuse of students/staff	20	17	0.494
habitually failing to do homework	9	3	1.786
habitually failing to do classwork	10	6	1.000

* Z-values were not computed where combined cell sizes were less than 10

** indicates a significant z-value at the .006 level of significance

fighting. This finding indicates that students receiving relaxation training are less likely to exhibit types of behavior which are considered unacceptable. One possible explanation of this finding is that students receiving relaxation training remain relatively calm throughout the day.

Results of the Study of Self-Concept

Testing, including the administration of the Self Observation Scales (SOS) to measure self-concept, occurred at the end of the relaxation training program. Teachers administered the SOS to the students, reading each statement aloud. The SOS is a nationally-normed, multidimensional instrument for measuring the way students perceive themselves (self-concept). The junior high level of the SOS measures seven dimensions of self-concept. High scores on each scale are most characteristic of the scale name. The scales are self-acceptance, self-security, social confidence, self-assertion, peer affiliation, teacher affiliation, and school affiliation.

Table 5 reports the means and standard deviations of the experimental and control groups on each of the seven subscales. The experimental group had a higher mean on all subscales except teacher affiliation. Whether significant or not, all results were in the expected direction, that is, the experimental group scored higher on all self-concept scales except affiliation with the teacher. Researchers used a split plot design to test each subscale for significant differences. The tests were two-way analyses of variance with schools as the random factor and

Table 5

Mean Scores of Experimental and Control Groups on Subscales of the Self Observation Scales

	Experimental		Control	
Subscale	Mean	St. Dev.	Mean	St. Dev.
Self-Acceptance	54.20	5.86	52.96	6.96
Self-Security	49.41	8.65	48.63	8.76
Social Confidence	48.06	10.16	46.88	9.78
Self-Assertion	53.55	9.70	51.40	9.63
Peer Affiliation	51.96	8.00	50.52	8.55
Teacher Affiliation	51.03	9.77	51.45	9.33
School Affiliation	48.94	11.33	48.93	10.30

Table 6

F Tests Between Experimental and Control Groups on Subscales of the Self Observation Scales

Subscale	Sum of Squares	F Value	Probability	
Self-Acceptance	195.93	4.86	0.0279	*
Self-Security	76.71	1.03	0.3097	
Social Confidence	176.75	2.28	0.1314	
Self-Assertion	590.94	6.70	0.0099	*
Peer Affiliation	263.23	3.91	0.0486	*
Teacher Affiliation	22.93	0.27	0.6011	
School Affiliation	0.01	0.00	0.9931	

* significant at the .05 level

experimental or control group as the fixed factor. As anticipated, schools differed on all seven subscales; however, this information is of little or no interest. Rather, researchers examined the main effect of experimental/control differences and the interaction between the two main effects. There were no significant interactions. Table 6 reports the sums of squares, F values, and probabilities associated with the experimental/control main effect only. Three of the seven tests are significant at the .05 level: self-acceptance, self-assertion, and peer affiliation.

Since the randomized groups could be considered initially equivalent, researchers attribute posttest differences to the experimental intervention. Apparently, the relaxation training program has a positive effect on self-acceptance, self-assertion, and peer affiliation. Self-security and social confidence, while not significant, also resulted in positive differences.

Results of the Study of Cognitive Differences Between the Experimental and Control Groups

The Comprehensive Tests of Basic Skills (CTBS) are administered to 7th graders by the South Carolina Department of Education in April of each year. The results of the CTBS for the students in the project are reported in Table 7. This table reports the mean scale score for the experimental group on the total battery and on the three subtests: reading, language, and math. Also reported is the difference between the mean for the experimental group and the mean for the control group. This difference represents actual scale score points where a positive

Table 7

Results of the Comprehensive Tests of Basic Skills *

School	Reading Scale Score	Reading Difference	Language Scale Score	Language Difference	Math Scale Score	Math Difference	Total Scale Score	Total Difference
1	670	-10	662	5	696	-3	676	-3
2	692	11	680	20	702	10	691	13
3	711	-9	686	-13	714	-1	704	-7
4	692	-5	666	-10	698	-2	685	-6
5	776	11	744	8	738	5	753	8
6	688	-3	674	-6	698	-5	686	-7
7	722	5	704	12	718	2	714	5
8	707	-5	688	-1	703	-5	699	-4
9	716	33	686	18	710	17	704	23
10	758	-2	734	-6	727	-4	740	-3
11	752	-16	728	-15	719	-3	733	-11

* "Scale Scores" represent the mean scale score for the experimental group. "Difference" is the number of scale score points difference between the experimental and control group means (control mean subtracted from the experimental mean).

number indicates a higher mean in the experimental group and a negative number indicates a higher mean in the control group.

Independent t tests were conducted between the experimental and control groups on each of the three CTBS subtests and the total battery. Classes were used as the unit of analysis (n=11). The results are shown in Table 8. None of the four t tests conducted were significant at the .05 level. The two groups do not differ on CTBS scores. In other words, simply participating in the relaxation exercises does not influence cognitive processes.

The CTBS scores were then compared to the wrist temperatures (relaxation indicators) in a series of scatterplots. Figure 3 plots the difference between prereading and postreading wrist temperatures against the difference between total CTBS scores for the experimental group and total CTBS for the control group. This figure shows that students who respond weakly to the relaxation training generally perform slightly lower on total CTBS scale scores than their control group which had no training. Possibly, the relaxation training reduces anxiety and thus reduces motivation to succeed on the CTBS. Six schools had mean wrist temperature increases which were small, less than 2.75 ^{o}F. (1.53 ^{o}C), and in all six cases the experimental group scored below the control group. For those classes in which the relaxation difference was 2.75 ^{o}F. or greater, however, the experimental group scored higher than the control group in four out of five pairs of classes. These classes exhibited a substantial increase in observed difference scores on the CTBS.

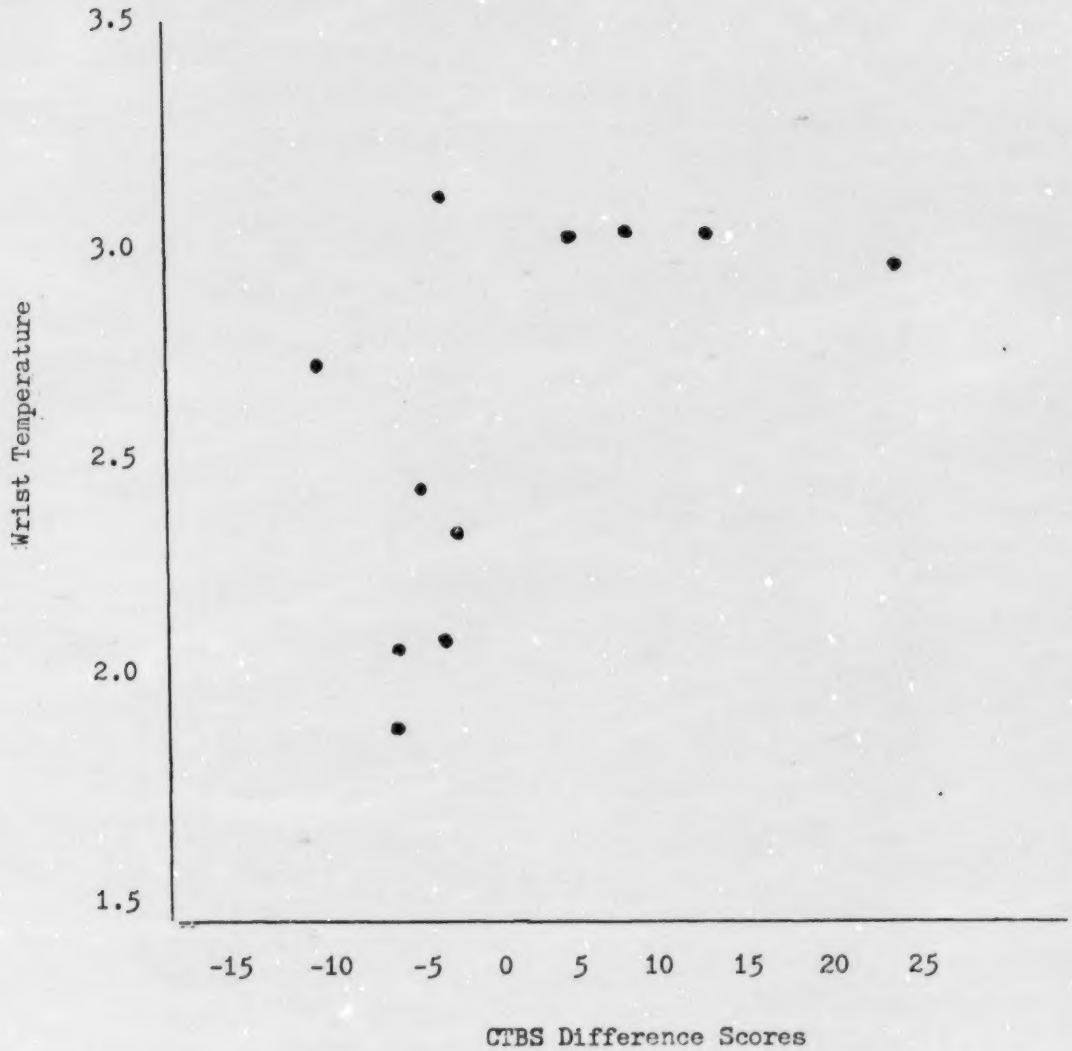
Table 8

Independent t-tests Between Experimental and Control Groups on CTBS Scale Scores

Subtest	Group	Mean	t value	Probability
Reading	Experimental	721.2		
	Control	720.1	0.22	.82
Language	Experimental	699.9		
	Control	698.8	0.24	.81
Math	Experimental	712.6		
	Control	711.8	0.45	.66
Total	Experimental	711.7		
	Control	710.4	0.35	.73

Figure 3

Scatter-Plot of CTBS Difference Between Experimental and Control Groups with Difference from Pre-Reading to Post-Reading Wrist Temperature



The data suggest the existence of a curvilinear relationship between physiological response to relaxation training and performance on the CTBS. The nature of this relationship masks the overall difference between the experimental and control groups (as noted in Table 8), but Figure 3 allows a clearer understanding of the relationship between relaxation response and performance.

Figures 4, 5, and 6 show the relationship between the experimental group's increase in wrist temperature and the difference between the experimental and control groups' performance in the CTBS reading subtest, language subtest, and math subtest, respectively. All three scatterplots indicate the existence of a threshold or minimum degree of relaxation necessary to produce changes in cognitive performance. At an approximate increase of 2.75 °F (1.53 °C) the data change. Classes, in which means are lower than 2.75 °, are characterized in each case by experimental groups which perform lower than the control group on the CTBS. When mean temperature increases exceed 2.75 °, the experimental group tends to outperform the control group. These results indicate that there is a threshold where relaxation training becomes effective. Participating in a relaxation program is apparently nonproductive if the skill is not learned well enough to produce large changes in physiological measures. When the skill is adequately learned, however, it is indicated that some cognitive gains can be achieved. This finding seems to suggest that if relaxation training is pursued until the student has mastered the skill of eliciting the

Figure 4

Scatter-Plot of CTBS (Reading Subtest) Difference Between Experimental and Control Groups with Difference from Pre-Reading to Post-Reading Wrist Temperatures

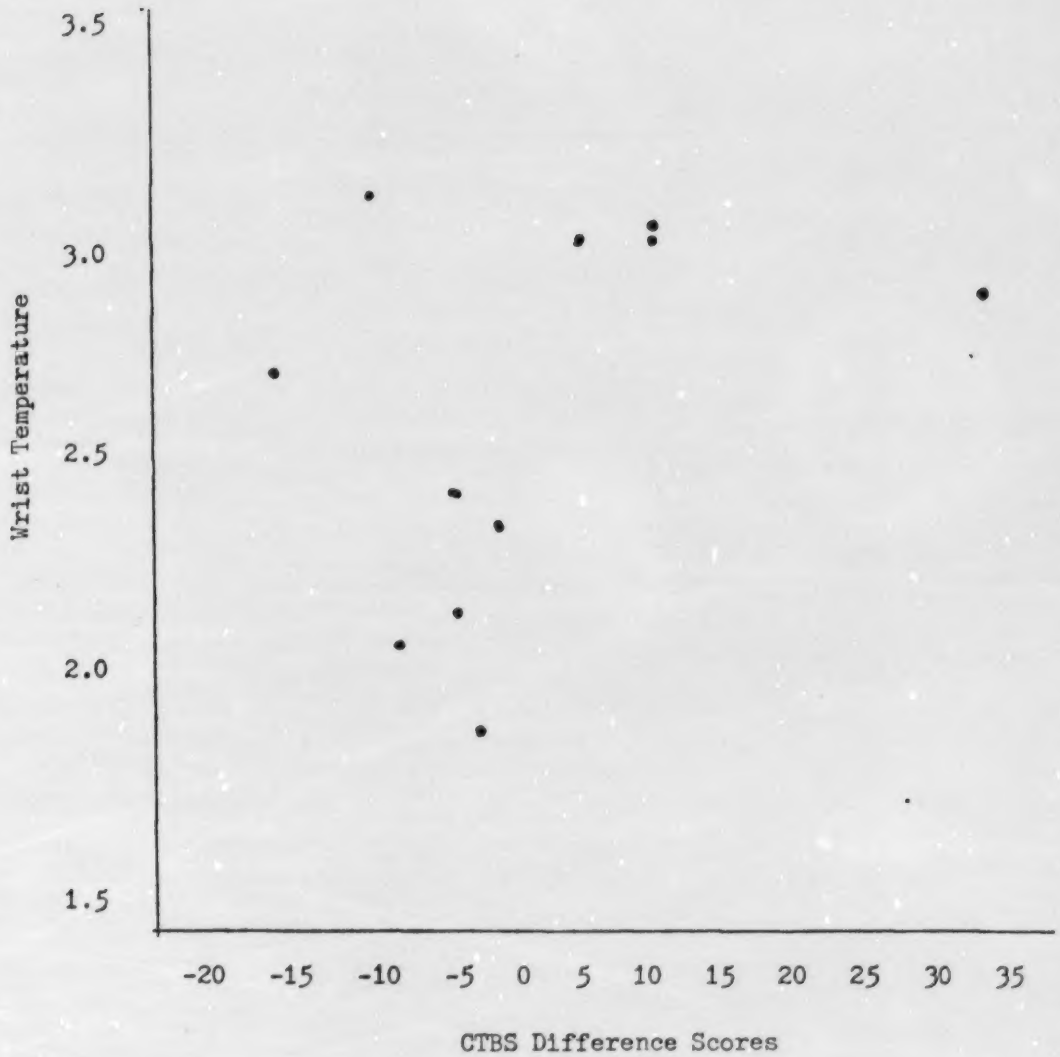


Figure 5

Scatter-Plot of CTBS (Language Subtest) Difference Between Experimental and Control Groups with Difference from Pre-Reading to Post-Reading Wrist Temperatures

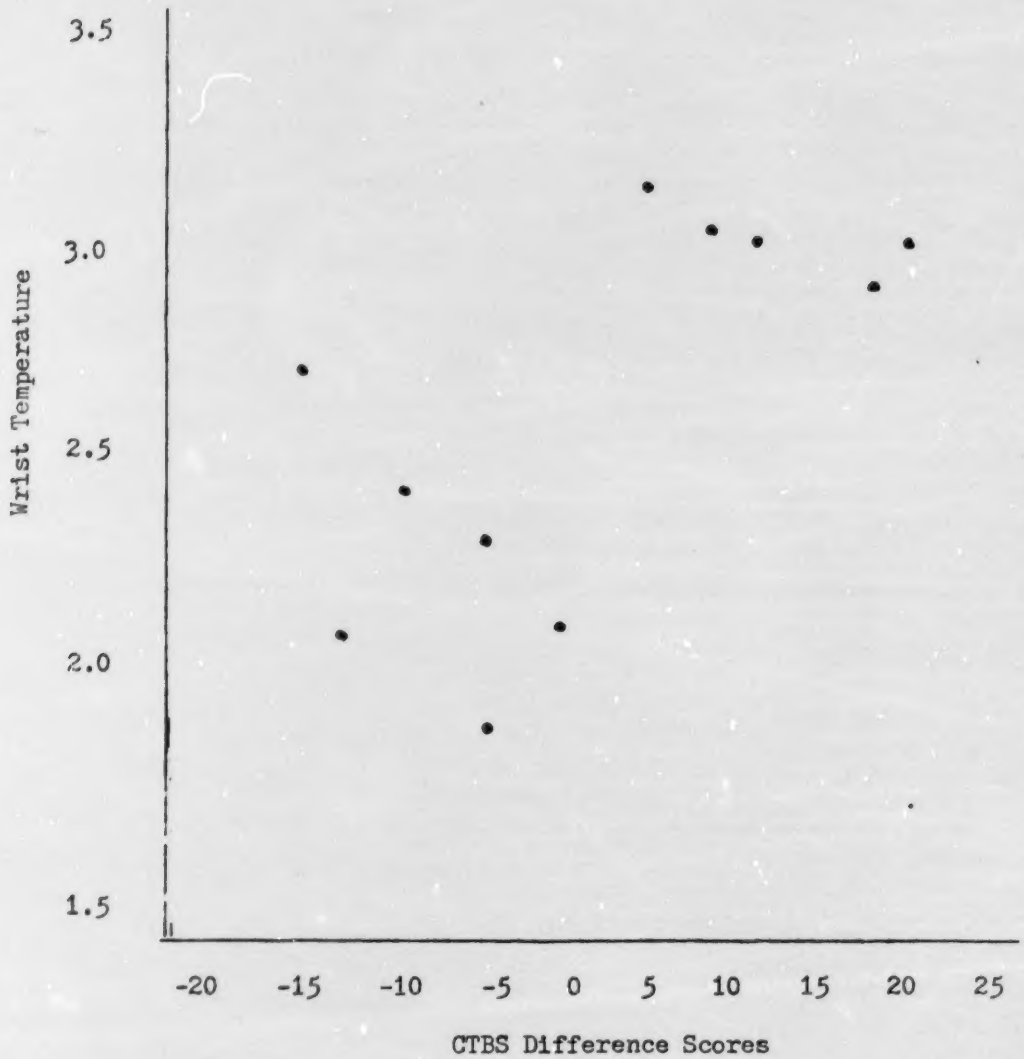
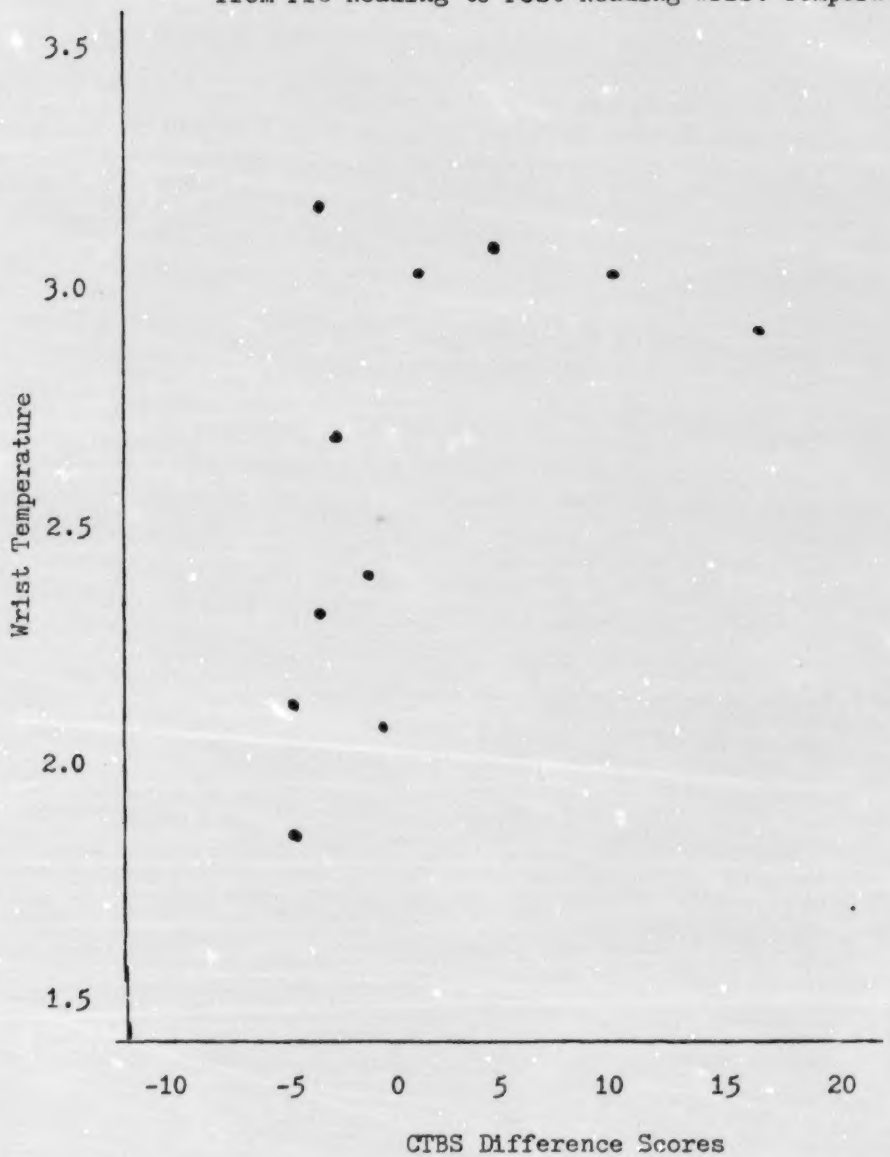


Figure 6

Scatter-Plot of CTBS (Math Subtest) Difference Between Experimental and Control Groups with Difference from Pre-Reading to Post-Reading Wrist Temperatures



relaxation response, there may be significant gains in learning. This hypothesis demands further examination.

Conclusions

This study examined the use of relaxation training in an educational setting. Specifically, researchers employed audio-taped relaxation exercises in the regular classroom and measured the relaxation response using wrist temperature indicators. The results provide valuable information in answering the following four questions:

1. Can relaxation training be implemented in the regular classroom?

Researchers encountered few problems in conducting a relaxation training program in the classroom. Relaxation exercises are short and can be managed by teachers after limited training. The entire program can proceed within the regular homeroom period. Students and teachers responded favorably to the program.

2. Is wrist temperature a valid and reliable method of biofeedback?

The wrist temperature data provides evidence of construct validity since the temperature trends followed the hypothesized trends. Wrist temperatures increased from prereading to postreading and this change increased slowly over time.

Wrist temperatures also appear to be a reliable measure of the relaxation state. Researchers computed a reliability

coefficient by dividing the variance of the wrist temperature increases across weeks by the average variance within each week (providing a measure of stability). The reliability coefficient was .979.

3. Is relaxation training effective on heterogeneous populations?

Unlike most previous studies which have focussed on hyperactive children or other special populations, this study examined a cross-section of middle school students. While students varied greatly in their ability to elicit the relaxation response, all students showed improvement. The ability to relax was not found to be significantly related to sex or race.

4. What are the positive effects of a relaxation training program?

Relaxation training, as implemented in this study, showed three positive effects. Students receiving the training had fewer discipline problems than students who did not receive the training. Apparently, the relaxation exercises reduce the tendency to exhibit disruptive behavior. Secondly, the students receiving relaxation training had significantly higher self-concept (specifically, self-acceptance, self-assertion, and peer affiliation) than students without the training. Thirdly, the ability to relax appears to be related to cognitive abilities. Although no overall difference was found on the CTBS between the experimental and control groups, classes which relax above a threshold outperform their matched control groups.

In summary, a large scale relaxation training program was implemented in the school system using wrist temperature as biofeedback. Students achieved gains in both cognitive and

affective areas. Also, researchers gained valuable information in program implementation and on wrist temperatures, especially the influence of ambient temperature. Relaxation training has tremendous potential to aid education and could eventually become a standard part of the school curriculum.

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